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Antonio Luigi Paolilli & Fabio Pollice *

Abstract: *»Trajektorien der Staatsbildung in Eurasia: eine Diskussion«*. Two questions have often been posed: 1) Why did humanity not take the path of Modernity already in Ancient times? 2) Why was it Europe that undertook the development towards Modernity? In this paper we will present an overview of these issues, trying to outline an interpretative hypothesis about the propulsive role that the presence, after the fall of the Roman Empire, of a plurality of political entities in a constant relation of competition and cooperation, had on the development of the European continent. At the same time we will analyze the evolutionary dynamics that pushed Europe, rather than China, India or the Arab world, towards Modernity.

Keywords: ancient history, state formation, Eurasia, cliometrics.

1. Introduction

A question that has often been posed is why did humanity not take the path of Modernity already in Ancient times. The question has relevance for Europe in particular, especially given the fact that in this region there was the highly developed Roman Empire, whose grandeur and opulence may make the subsequent decadence and fall seem inexplicable.

Another question, however, seems inevitable: why was it Europe that undertook the development towards Modernity[1]? Other regions of Eurasia had achieved remarkable levels of technology, often higher than in Europe, particularly in the Middle Ages, but without experiencing the revolution in the social and productive system that above all from the end of the eighteenth century characterized the history of the West, a revolution whose premises were already found in the Commercial Revolution of the Late Middle Ages.

One of the possible explanations is that the geo-political situation of Europe, after the fall of the Roman empire, was characterized by an extreme fragmentation and instability.

In this paper we will present an overview of these issues, trying to outline an interpretative hypothesis about the propulsive role that the presence, after the

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[1] See Vincent, 2002 [1995], p. 81.

fall of the Roman Empire, of a plurality of political entities in a constant relation of competition and cooperation, had on the development of the European continent. At the same time we will analyze the evolutionary dynamics that pushed Europe, rather than China, India or the Arab world, towards Modernity.

2. East and West Eurasian Societies: A General Discussion

The comparison between the Eurasian societies has been studied not only by historians, but also by geographers. Among the works of historians, we must mention the research of Scheidel (2007), concerning the comparison between Chinese and European civilities (see also Cosandey, 1997; Lang, 1997; Pomeranz, 2000). This research poses in particular the question of why the history of the two regions showed a convergence until the sixth century A.D., followed by a remarkable divergence.

In the geographical field a similar problem has been posed by Diamond (1997), who analyzed the development of civilization, following the agricultural revolution, in various regions of the world, including China, India and the Mediterranean.

About the comparison between the Chinese civilization and that of Western Eurasia, Scheidel examines the proximate and the ultimate causes of the convergence in Ancient times and the later divergence between the two civilities.

As regards proximate causes, Scheidel uses Wickham's interpretative model (Wickham, 2005), noting above all that in the context of fiscal decline and decentralization of political and military power of West Eurasia, much more intense than in China, "it became harder to maintain state capabilities (especially in the military sphere), economic activity was curtailed, and the prospects for the restoration of a stable core-wide empire were poor" (Scheidel, 2007, p.3).

If it is true, however, that the final completion of this process of transformation from an economy with a relatively high intensity of trade and a strong centralized state to one with the opposite characteristics was achieved by the Islamic invasion. It is also true that it had begun centuries before, with the decline of the Roman Empire.

The causes of the decline of the Roman world have been widely investigated. The argument, already raised by Gibbon (1776), has been addressed by Rostovcev (1926) and Walbank (1946), who posed the problem of why the economic system of the Roman Empire was unable to continue its growth to arrive at an industrial take-off. Among recent scholars, we must cite Ward-Perkins (2005) who, opposing the thesis that the Empire underwent a transformation rather than a decline and a real fall, underline that the invasions of the Germanic tribes were for the Romans a traumatic event which undermined the economic and social structures of the invaded territories. The scholar discusses a series of events that contributed to Rome's fall, such as the decline of the

Roman military machine, the civil war, and a sequence of ineffective emperors. A similar opinion is that of Heather (2007), who reviews many reasons which may justify the fall of the Roman Empire, constituted by a pernicious combination of external causes (principally the pressure of the Huns) and internal causes.

On the other hand, Homer-Dixon (2006), who bases his analysis on the confrontation between economics and thermodynamics, believes in more endogenous and deterministic causes. For Homer-Dixon the success of the empire depended on its ability to extract surpluses from the imperial territories and concentrate them at the centre, where they enabled the development of a very complex organization. As the state was growing, the reaching of an equilibrium between the flow of resources and the size of those necessary to conquer far-flung territories was a turning point, from development to recession.

An economic and social explanation of the reason the Roman economy did not develop towards Modernity has been furnished by Schiavone (2002 [1996]), who asserts that this development was rendered impossible by the domination of the slave economy and the absence of a philosophy making productive labour worthy of consideration.

More recently, Paolilli (2008), referring on the data presented by Parker (1992) and related to the shipwrecks occurring in the Mediterranean Sea in Ancient Times, strengthened the argument put forward by Hopkins (1981) who, although the shipwrecks seem to follow the profile of a *normal* curve, with its peak near the beginning of the Christian age, does not deduce that trading across the Mediterranean was more intense in the two centuries before the birth of Christ than in imperial times, attributing the greater number of shipwrecks in the former period to piracy, which was interrupted under Pompeus. The same data are in fact differently presented by Paolilli who shows that the real peak of the shipwrecks (and therefore, presumably, of trade), excluding the effect of piracy, came in the middle of the 2nd century A.D. Paolilli also considers the thesis of Duncan-Jones (1994) who, revealing a considerable degree of monetization of Roman society[2], notes that the monetary circulation seems to have been local rather than Mediterranean, and this appears true above all for the centuries after the second century A.D. Lo Cascio (2003) provides an explanation of this phenomenon, suggesting that the transfer of money from the provinces to Rome and vice-versa happened only for the settlements and that this, therefore, does not imply a scarcity of Mediterranean

[2] The considerable degree of monetization of Roman society estimated by Duncan-Jones is confirmed, as cited also by Paolilli (2008), by the research into the composition of ice layers in Greenland and into lake basin sediments in Sweden, Switzerland and Spain (Hong, Candelone, Patterson, Boutron, 1994, 1996; Hong, Candelone, Soutif, Boutron, 1996; Renberg, Persson, Enteryd, 1994; Shotyk, Weiss, Appleby, Cheburkin, Frei, Gloor, Kramers, Reese, van Der Knaap, 1998).

trade. As mentioned above, moreover, evidence of the localization of monetary circulation seems to exist precisely for the centuries following the end of the adoptive emperors' dynasty. Following Lo Cascio (2003), who asserted that Italy, which enjoyed a flow of money from the provinces, experienced centuries of higher prices compared to the provinces, to the progressive detriment of its internal production, wrong-footed by the competition from the provinces, Paolilli (2008) concludes that the political unity of the Mediterranean Sea was the outcome of a co-evolutionary phenomenon between the growth of Mediterranean Sea trade and the forming of a single state along its coasts, and that the effective unity of this state was possible only as long as Italy remained its economic (as well as geographical) centre. It must also be considered that the Roman economy was based on the army which, with the enlargement of the Empire, was more expensive but yielded less, and that the elites were consumers of imported luxury goods, expensive for the Empire's economy. The economic decline of Italy, therefore, provoked the collapse of Mediterranean trade, rendering obsolete the political unity of the territories around it, as is attested by the evidence of the localization of monetary circulation in the Late Empire and the growth of local political experiences (Imperium Galliarum and Zenobia reign firstly, Tetrarchia later). Paolilli, however, also referring to the results of two mathematical models previously used (Paolilli, 2005a; 2005b), asserts that the collapse of Mediterranean trade led to a progressive economic despecialization, with a return to bartering, and a consequent implosion of production. In this respect, the viewpoint of Paolilli is similar to the interpretative model cited above (Wickham, 2005), followed by Scheidel to investigate the proximate causes of the divergence between East and West Eurasia after the 6th century. It must be pointed out, however, that Paolilli's analysis is focused on long-term factors, albeit economic and social, due to the fact they are seen in a geographical context, making them more similar to the ultimate causes studied by Scheidel.

Scheidel, in fact, holds that the proximate causes of the divergence are only the effects of deeper factors (the ultimate causes). Among these he distinguishes geographic, demographic and ideological factors and the nature of the earlier government institutions and the subsequent regimes.

On geography, Scheidel notes that

> The absence of very large states from Europe (with the temporary exception of the Roman Empire) is a feature that constitutes an anomaly in the temperate zone that stretches east-west across Eurasia (Scheidel, 2007, p. 6).

Moreover he admits that it was easier to maintain a single very large state in China, since that region is compact and shielded on three sides by mountains and ocean, but notes also that

> the presence of an inner sea core in the form of the Mediterranean Sea and of navigable rivers that crisscross its hinterlands might well be considered more

> conducive to unity than the parallel river valleys that segment China and the historically marginal position of the Pacific Ocean (Scheidel, 2007, p. 6).

In fact, as we have seen, this is what happened, at least during the Roman age.

Also as regards the other ultimate causes, Scheidel believes that they may be decisive in explaining the divergence between East and West Eurasia, but he does not think that any one of them is the certain key factor.

Finally Scheidel (2007, p. 12) retains that

> Even 'short-term' explanations may ultimately be embedded in 'long-term' trajectories such as the character of state formation. This adds considerable weight to the question of how the presence or absence of a near-monopolistic super-state shaped the preconditions for modern economic growth and levels of well-being.

As mentioned above, a quite similar viewpoint is expressed by Diamond (1997). Asking why some populations such as Aborigines have not been capable of building, in various millennia, a complex society in areas where Europeans, by contrast, reached this stage in few decades (2006 [1997], pp. 235-255), Diamond notes that Europeans, such as Asians, live in a large continent (Eurasia, including Nord-Africa) whose main axis is east-west oriented. Due to this orientation the communications and transfers (of information, technologies, people, animals and plants) are easier than in the case of orientation along the meridians, since it is not necessary to overcome frequent climatic barriers. Europeans arrived in Australia with a technology (and also with a population size) which was the outcome of an evolution occurring elsewhere, and not in Australia, where the very harsh environmental conditions had never allowed a hunter-gatherer population to evolve towards Modernity, simply because the technological and social gap was too big and therefore it was autonomously unbridgeable, in that area.

Diamond's approach is also gaining growing support from economists. Starting from Diamond's work, Olsson and Hibbs (2005) have built models which can estimate the per capita income for the three main economic systems adopted by mankind (economy of hunter-gatherers, agricultural economy, the industrial economy). The main conclusion reached by Olsson and Hibbs is that the current levels of economic development are positively correlated (at least for 50%) to the initial bio-geographic conditions. The scholars have utilized five key variables: continent size, major axis of the continents, climate, number of animals that can be domesticated, number of plants that can be grown domestically. The main factors in the causal sequence identified are the size of the continents, their orientation and climate. These three factors directly influence the availability of plants and animals that can be domesticated, which in turn is the main cause of the time necessary to change a hunting and gathering economy firstly into an agricultural economy and, then, into an industrial economy.

The latter factors (the availability of plants and animals that can be domesticated), finally, together with the first three, are directly correlated to current income and development levels. The economic development of various regions of the world therefore seems to be directly influenced by the time that has passed since the agricultural and industrial revolutions (substantially by their technological "seniority") and, both directly and indirectly (i.e. by this technological seniority), by the size, orientation and climate of the continents, which are then the remote causes of the development, but also, partially, the proximate (or direct) causes. The large size of a continent favours the constitution of numerous societies in competition with each other. The prevalently longitudinal orientation (as in Eurasia), as we have seen, favours the transfer of persons, animals, plants, goods and information. It has been noted (Diamond, 2006 [1997], p. 357, 360-361) that technological progress, also in modern companies, is favoured by a balanced mix of competition and information circulation (which can be regarded as a form of cooperation). Big companies, organized in highly hierarchical form, appear to be less efficient than others, equally large but with a less hierarchical organization, composed of relatively independent units which are competing with each other, but not enough to impede the flow of information. Another example of this type of economic and productive interaction is represented by industrial districts, where innovation, enterprise and territorial development are the result of the relations of competition and collaboration established between the different production units and between these and other spatial components (Marshall, 1919). Competitiveness thus seems positively correlated with the level of relatedness and this is due to the fact that the greater the relatedness, the greater and the faster is the exchange of information between the production units. It should also be considered that the presence of a plurality of competing players, close enough to influence each other, increases the probability of success of the group as a whole because, as shown by the studies on technological innovation, when one of the competing players implements a more productive behaviour, this behaviour is quickly imitated by other actors.

A similar situation seems to characterize states: in this regard it is usual, as mentioned above, to compare Europe, China and India (Diamond, 2006 [1997], pp. 357-358). The first, which has a very rugged territory, was almost always divided, but not enough to prevent the internal movement of information, people and things, while the second was almost always united, due to the compactness of its territory, with easy means of communication. India, finally, is the sub-continent which has known, with the exception of certain historical periods (essentially four, namely those of Maurja, Gupta, Mogul and English empires, the last of which of foreign origin) marked internal divisions.

All three of these sub-continents reached considerable levels of civilization, but only the first was able to promote a process of economic, political and social development which reached a global dimension and progressively conquered all other areas of the planet. Actually a similar process was happening in China in the fifteenth century, when its large fleet sailed the Indian Ocean, but a political upheaval, driven by a few individuals placed at the top of the institutions, was sufficient to cause the total abandonment of any expansionist policy and the withdrawal of that great country into itself (Diamond, 2006 [1997], p. 318). If there had been more divisions and more internal competition, such a political upheaval could not have covered the whole country and maybe the political and economic geography of the earth would now be quite different. In Europe, instead, divided in the same period into various political-territorial entities, large enough and financially able to support advanced research and the development costs of new trade routes, but not so divided as to impede international trade – the control of which was the aim of much of the military competition – exploration opened up roads for the conquest of the world.

Also the relation between institutions and geography, then, seems undeniable. Olsson and Hibbs too (2005) pose the problem of the influence of human institutions in determining economic development, and of the possibility that the same institutions can be influenced by geographic factors, showing a significant correlation also in this case.

The new hypothesis proposed by Diamond and substantiated by the research of Olsson and Hibbs seems to revive the argument of geographic determinism. Olsson and Hibbs, moreover, while highlighting the significance of political and institutional conditions in determining the developmental trajectories of a company, stress at the same time that these conditions are also influenced by the geographical factors described above. Influenced but not determined, because the interaction that links human and natural factors in a specific geographical space never takes a strictly deterministic connotation. As Diamond himself stresses, the anthropic factor – represented in this case by the political-institutional conditions – can play such an important role as to greatly diversify the fates of societies found in very similar and even contiguous territories[3]. Human history, then, can play a role comparable in importance to that played by geographical factors, as already stressed by the historian Cipolla (1985, pp. 137-142), when he talks about the importance of the so-called "reazione creativa della storia" (creative reaction of history). The interpretation furnished by Diamond can also be related to the pioneering thesis of Prigogine who, reflecting on the evolutionary tendencies of humanity (1979, pp. 54-66), underlines that the social, cultural or economic evolution of a population is driven by essentially casual events (innovations), but whose effects are amplified or not

[3] The author, for example, describing the great economic and social differences between the Dominican Republic and Haiti, two states which share the territory of Hispaniola, underlines that the events of Hispaniola are a real antidote against environmental determinism (2005 and 2007 [2005], p. 346).

amplified depending on the deterministic constrictions imposed by the existing structures. The author believes, in particular, that in some circumstances, and precisely when social systems are in a condition of instability, the evolution of these systems can be deeply influenced by the actions of single men or events. The phenomenon, and the risks connected to it, are effectively described by Buchanan (2008, p. 165), when he observes that it is interesting to reflect on the hierarchical organization of our societies, which place a few individuals in positions of great power.

It should be stressed that, although in some moments even single men and/or events may change the course of history, much depends on the context and, more specifically, on the already mentioned political-institutional context.

As discussed above, if the context consists of a single state, almost isolated, single events can be decisive, but if there is a set of interacting and interdependent states, their effects can be absorbed or integrated by the system due to the dynamic that develops between the individual states. In other words, whilst not allowing forecasts for its individual components, the system of interacting states shows a greater predictability of its global evolutionary process.

3. Mare Nostrum – Christian Europe: The Transmutation

To understand the causes of the divergence between the European continent and China it is necessary to consider that between the Western Roman empire (convergent) and the medieval Christian area (divergent) there is a substantial political, economic and geographical difference. The great divergence begins in fact in the early Middle Ages, when the Western Mediterranean – having already declined at the economic level and been definitively ousted by Islamic expansion – died and was replaced by the "modern" Occident, which identifies itself in Christian Europe. Medieval Europe differs from the Roman world in many respects, while retaining some basic features. Among the differences we find the Christian faith, which however was already present in the Late Empire. The diffusion of this faith was in fact facilitated by the Roman roads, but in the Middle Ages it permeated ever the individual and social life of European populations ever more deeply. But it is mainly the transformation of what was the European part of the Roman world in a continental society, surrounded by sea rather than facing the sea and trading across it, that is the crucial element distinguishing the old from the new order. The sea no longer performs the role of decisive factor of territorial specialization in production, as in the Roman world, whose prosperity was due to sea trade.

As illustrated above, the collapse of the "Mediterranean economic model" had already begun in the second half of the 2nd century, with the decline of Mediterranean trade. Western Europe, particularly, suffered a progressive economic decline which weakened its capacity to resist invasion. This led to an increasing cost of restoration of capital, damaged by military events[4], thus making many commercial activities uneconomic and pushing the economic system toward a de-specialization process, with lower and lower revenues. The society was reorganized in increasingly short-range economic activities and with the aim of territorial self-sufficiency. Slavery became a less and less frequent state, with the complicity of the Christian faith. Christianity, though already dominant in the Late Empire, had not been able to suppress it (*Paul* of *Tarsus* spoke about the inevitability of servile labour) due to the resistance of the imperial economic structures. During the Middle Ages, however, the political and economic conditions profoundly changed mainly because it became difficult to trade with ease across the Mediterranean[5]. In this period Europe became a source of slaves rather than a land where they are used. When therefore, due also to the pressure of various invaders, large sectors of the rural population settled in towns to defend themselves (Duby, 1992 [1973], pp. 148-149), these populations shared one faith. The subsequent development, made possible by a series of climatic, political, cultural and economic factors – the most important of which was the gradual petering out of invasions from the 10th and 11th centuries on, with the long period of relative peace that followed in Europe (Duby, 1992 [1973], pp. 143-154) – was not hampered by an economic system with a predatory structure[6]: nothing could discourage the use of machines.

In the past it has been argued that the Commercial Revolution derived from the clash between the bourgeoisie and the nobles. More recently, on the other hand, it has been argued that this revolution was the result of the interaction between the two classes[7], while not forgetting that this period saw numerous and widespread riots and revolts – most frequently, however, where the power within the town was held by clerics – and that these events helped to strengthen the power of the emerging class. In this historical period, feudal aristocracy, merchants, artisans and peasants too were urbanized or lived around and in the town, sharing a unique conception of life: the pressure of the invaders set off a reaction triggered by the catalyst of the clergy, as well as Christian thought which, interacting with the ideal of returning to the glorious Roman past and the rediscovery of classical authors, would support a new culture, profoundly changed.

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[4] About the influence on economic equilibrium of the cost of war, see Paolilli, 2005a, 2005b.

[5] The western basin of the Mediterranean sea had been, as the Arab historian Ibn Khaldun admitted, almost at the mercy of raids by the Muslims who, with the conquest of Sicily, had also virtually separated it from the Greek-Byzantine area (Pirenne, 2000 [1937], p. 156).

[6] On the predatory character of many states of the pre-modern world, see Cameron (2005 [2003]) and Keay (2001 [2000]), pp. 221-232.

[7] To this end see: Baschet (2005 [2004]).

4. The Development: An Interpretative Mathematical Model

On the basis of the considerations made above, the dynamic interaction between economic and political systems in competition is one of the main factors that allowed medieval Europe to move towards Modernity, reaching a level of technological and organizational development which has assured to it a prolonged global supremacy. In the following pages we will try to develop an evolutionary model which simulates the competitive-collaborative interactions[8] between economic and political systems (henceforth: EPS) within a closed regional framework – i.e. characterized by no significant interactions with the outside world – with the purpose of analyzing the effects of long term impact on levels of development.

The dynamic model we are presenting can also take the technological and socio-economic evolution into account. Even if we see economic development as a result – although it is also a cause in a circular and evolutionary interpretation of development – the model of innovative processes that concern the technological, social, political and cultural field in fact focuses on the effects of the competitive interaction between political-economic systems on technological progress and development levels. Here the simplification does not reduce the explanatory purpose of the model, since the interaction processes that occur in technology are not very different from those manifested in the political and social field.

The economic and political systems could also be regarded as poles, because states, especially in the past, had a political and economic order characterized by an interaction model that tended to reinforce the dominance of the centre over the periphery by means of systematic drainage of resources produced by the periphery and their redeployment to the direct or indirect benefit of the centre.

The fact that the poles are by definition concentrated in a point of space and have, with increasing distance, a decreasing influence, may make us think that the model we are presenting is more appropriate for describing interactions between cities than among states, which are more extended in space. This objection, however, is not relevant if we consider that generally, rather than a suppression of the surroundings EPS, we see a "diffusion" of the central organization over the territory, with the setting up of cooperative relations (though characterized by unequal exchanges) with the dominated EPS. In other words, rather than focusing on the poles in the strict sense of the term, our work focuses on the human organizations which, even if structured around an institutional (or economic) and geographic centre, can have a varying territorial size. The case of diffusion over a territory which was previously dominated by other organizations, as we will show below, can then be easily described by the

[8] The interactions can be of a concurrence or collaborative kind.

model we are presenting, by increasing the value of the parameters that quantify the degree of cooperation, or synergy, in the dominant organization (which has spread over the territory so as to constitute a larger system).

Before tackling the problem of the relation between technological progress and economy, however, we must define the concept of “innovation”. Following the Schumpeterian approach to the issue of innovation (Schumpeter, 1911), we will distinguish type A innovations, which generate a significant and unpredictable change, and type B innovations, which are predictable improvements in goods, productive organization and productive techniques. The first – which in addition to new goods and productive techniques, can also concern the organization of the society – can also modify the interpretative paradigms of reality, and their insurgence can be the result of chance, although they, like type B innovations, can sometimes be interpreted as the result of certain socio-economic contexts. Being inherently revolutionary, however, it is difficult, if not impossible, to predict their onset, it being possible only to estimate the receptivity to them of a given socio-economic system.

Type B innovations, on the other hand, can easily be incorporated into an evolutionary model. Being of incremental nature, these innovations in fact tend to have an evolutionary trend that follows a specific technological trajectory and are therefore easily predictable in their temporal and geographical occurrence.

In the following paragraphs we will present a mathematical model designed to study the conditions that can facilitate or impede the development of an EPS with particular attention to the effects of competitive-collaborative interaction with similar economic and political entities within the same geographical context. The model is composed of as many differential equations as there are EPS interacting in a given geographical context. However, to make it easier to understand the description of the model we will apply it to two EPS only. The model will subsequently be enriched by taking the technological level as a variable too, though only as regards type B innovations.

4.1 A Model of Interaction of EPS with a Given Technology: General Form

Assuming that the growth of a given political-economic system depends not only on factors internal to the system itself, but also on dynamic interactions with similar systems within the geographical region – mainland area – to which it belongs and wanting to measure the effects of these interactions on the growth trajectory of this system and of those connected to it by this interaction, the interpretative model proposed here focuses on the study of these interactions. The mathematical model considers two forms of interaction: a positive developmental impact of synergies that can arise between two or more territorial units, the other negative, represented by the constraint that the development of each entity represents for the others.

The general form of the model which we present is therefore the following:

$$\frac{dx_i}{dt} = k_i x_i \left[\left(\sum_{j=1}^{n} \frac{s_{ij} x_j}{R_{ij} + x_j} \right) x_i^{\alpha_i} - \sum_{j=1}^{n} t_{ij} x_j \right] \quad \text{where } i = 1 \ldots n \qquad (4.1.1)$$

It describes the dynamics of *n interacting* EPS, each with an economic mass x_i, and it is composed of *n* differential equations. The measurement unit of the economic mass can be identified in an economic actor. For the sake of simplicity we will assume that all economic actors have the same dimension and characteristics[9].

The variation coefficient of the mass *i* is k_i, and the variation itself depends on the expression in square brackets, which measures the residual expansive potentialities of the EPS *i*. The summation in round brackets shows the coefficient of synergies induced by the presence of the masses x_j (i.e. the synergies deriving from the internal relations of the EPS added to those induced by the relations with other EPS). We can assume in fact that the productivity of an organization is directly related to the synergies which, in turn, are directly related to the dimension of the same EPS or the EPS with which there are complementary relations. The relation between the synergies and the economic mass is direct, but the growth of synergies cannot be unlimited; otherwise, in fact, the system would grow indefinitely.

The summation in round brackets, which refers to the internal synergies of the organization added to those with other EPS, is therefore a set of homographic functions of the same synergies. The latter, therefore, grow in dependence of the masses x_j, tending to the values of the s_{ij}, which are their limit values, with decreasing increments. The R_{ij} are form parameters of the homographic functions, where the

$$\frac{s_{ij}}{R_{ij}}$$

measure the initial inclination of the same functions. The summation in round brackets therefore represents the global synergy coefficient which, multiplied by $x_i^{\alpha_i}$, measures the growth potential of the EPS *i*. We can recognize in this a particular kind of Cobb-Douglas production function, with a single production factor x_i , multiplied by a coefficient here constituted by a sum of homographic functions and elevated at the exponent α_i, whose value we assume to be less than one to describe a context in which the scale economies are decreasing (in the opposite case the growth of the EPS would be explosive). The particular

9 We could also identify the economic mass with the population, assuming an equal income for the individuals.

form of production function presented here is different from a common Cobb-Douglas function not only in the presence of homographic functions which make the coefficient that multiplies the productive factor variable and in the fact that this factor is unique, but also because this coefficient, which in a common Cobb-Douglas is linked to the technological level, here measures only the effects of the synergies. The technological level, finally, is expressed by the exponent α_i. These latter choices, however, are not new (see Paolilli, 2005a, 2005b, 2008, 2009) and they enable the effects induced on the production by different but normally interrelated factors, to be clearly separated into synergies and technology.

Lastly, the second summation measures that part of the potential growth which is already exploited by the interacting EPS. The coefficient t_{ij} measures the effect of the concurrence of an EPS j on the resources available for the EPS i. We assume that the value of t_{ii} (resources taken from the EPS i by its single operators) has a unitary value because we assume, for the sake of simplicity, that within an EPS the resources are equally accessible for all the operators of the EPS, and each of them takes from others exactly the resources which are necessary for the survival of a single operator.

The effects of the distance between the EPS on their interactions, though the distance is not explicitly considered in the mathematical model, are implicitly expressed by means of the values of the coefficients t_{ij} and s_{ij}. In fact it is reasonable to assume that both the synergic and the concurrence interactions become less intense with the increased distance between the EPS, since both are hampered by growing costs of the transfer of raw materials, goods and services.

Note that in the following graphic and numerical elaborations we will assume, for the sake of simplicity and also for the purpose of studying a scenario in which the interaction happens between EPS that are as similar as possible, that the values of the concurrence coefficients t_{12} and t_{21} are equal. Also the form parameters R_{11}, R_{22}, R_{12} and R_{21} will be assumed to be equal. The equality between the latter and between the t_{ij} (with $j \neq i$) will be maintained in all the simulations and therefore the form coefficients and the concurrence coefficients will be respectively indicated in all the figures with R and t. Also note that $t_{ii} = 1$; therefore this parameter will not be indicated.

4.2 Case of Two EPS, With Technology as a Given

Figure 4.2.1a shows a situation in which two EPS are so near to each other that they compete for the same resources (Figure 4.2.1b shows instead a detail of Figure 4.2.1a, near the origin of axes). The EPS also have a subsidiary relation: the values of the s_{ij} are positive, even if far lower than the s_{ii}. The positive panel is divided into zones marked by the letters A, B, C and D. Zone A covers all the values of x_1 and x_2 for which both the EPS grow. The zones B and C identify the values of x_1 and x_2 for which, respectively, only x_1 or x_2 grows, while in zone D both x_1 and x_2 increase. There are the following equilibrium points: E_0 (origin of axes, with extinction of both the EPS), E_1 and E_2 (survival of only one EPS, respectively *1* or *2*), E_3 (survival of both). There are also points E_4, E_5 and E_6. The latter is very near to the origin of axes (survival of both the EPS with very low values: see Figure 4.3.1b). However they are points of unstable equilibrium: each perturbation, even if very slight, will push the system towards a stable equilibrium point.

In the equilibrium point E_3 the mass of the single EPS is smaller of that of the surviving EPS in the equilibrium points E_1 or E_2, due to the low values of the s_{ij}, even if the global mass $x_1 + x_2$ is greater there.

Figure 4.2.2, instead, shows an analogous situation, but with much higher values of s_{ij} (*5* instead of *0.5*). Also *t* is greater: *0.2* instead of *0.15* (the reason for this choice is in the need to make a comparison with the following figures). We can note that in the equilibrium point E_3, with both the EPS vital, the mass of a single EPS is far bigger than the mass of the winning EPS in the equilibrium points E_1 and E_2. The coordinates of the equilibrium points E_1 and E_2 are however the same as the analogous points of Figure 4.2.1a, because in the absence of the other EPS the relative synergies and the effects of concurrence disappear (see in this respect 4.1.1). However, we cannot conclude that the survival of numerous EPS certainly generates a higher global output and greater prosperity. The actual expansion of the influence of an EPS, as mentioned above, does not necessarily generate the suppression of the rival EPS. For the purpose of more intensive land use, in fact, it is likely that the declining EPS is integrated in the system of expanding EPS, promoting its specialization and thus increasing its synergies with the latter[10]. This scenario can be described by increasing the value of s_{11} or s_{22} (depending, respectively, on the prevalence of EPS *1* or *2*).

Figure 4.2.3 refers to a context in which one of the two EPS, (EPS 2), acquires a technological advantage over the other. The value of $_2$ is in fact *0.62*, while that of α_1 is *0.6*. Although the difference between α_2 and α_1 does not seem great, the consequences are significant: zone C grows at the expense of zone B, leading to the disappearance of the equilibrium point E_3. It is therefore not possible for both the EPS to survive: in most cases the EPS which has the technological advantage will prevail. The opposite case, in fact, will happen only if the initial value of x_1 is far higher than the initial value of x_2 (residual zone B, near the x_1 axis). An important consequence of this scenario is, however, that the total mass $x_1 + x_2$ will be considerably less than that reached, in case of equal technology, in the equilibrium point E_3 of Figure 4.2.2. This is due, as already mentioned, to the disappearance of the synergies between the EPS: the

[10] An historical example is provided by the story of Rome and Carthage. The later, a rival of the former, was destroyed by it, but after some time it was rebuilt because it was necessary for the exploitation by Rome of African resources.

surviving EPS must rely only on itself for exploiting the resources offered by the territory. Obviously also in this case we can note that the winning EPS can integrate the other one, for the purpose of better land use, thus increasing the value of its s_{ii}.

Figure 4.2.4 illustrates a situation similar to that of Figure 4.2.3 (with $\alpha_2 > \alpha_1$), but with a lower value of t (*0.1* instead of *0.2*). This signifies that the concurrence between the EPS is reduced, for example due to a greater distance, but without a fail of the synergies. The equilibrium point E_3 appears again, and even the areas **B** and **C** adjacent to the axes, which involve the extinction of one of the two EPS (equilibriums E_1 and E_2), are very small.

Figure 4.2.5 shows that the equilibrium point E_3 can become unstable for sufficiently high values of t. The assigned values are the same as Figure 4.2.2, except for t, which is higher (*0.25* instead of *0.2*), describing a situation with more competition. The areas B and C reverse their position: if by chance the system is in E_3, a slight perturbation is sufficient to push the system towards E_1 or E_2. It is possible however that the system still converges to E_3, if the x_i have identical initial values (see Trajectory Tb, in Figure 4.2.5).

There is an inverse relation between t and the values x_1 and x_2 of the point E_3: if t increases, E_3 approaches the origin of the axes, while areas B and C bordering it are progressively reduced and finally disappear, when the curves

$$0 = k_i x_i \left[\left(\sum_{j=1}^{2} \frac{s_{ij} x_j}{R_{ij} + x_j} \right) x_i^{\alpha_i} - \sum_{j=1}^{2} t_{ij} x_j \right] \qquad \text{(with i = 1,2)}$$

have the same inclination and the equilibrium point E_3 loses its stability. There is also (and above all) a trade-off between the value of t which makes the point E_3 unstable as well as the technological level, measured by the α_i: when the latter increases, in order for E_3 to remain stable, t must decrease (Figure 4.2.6 and Figure 4.2.7), and this happens because in an economic sense, technological progress reduces the distance.

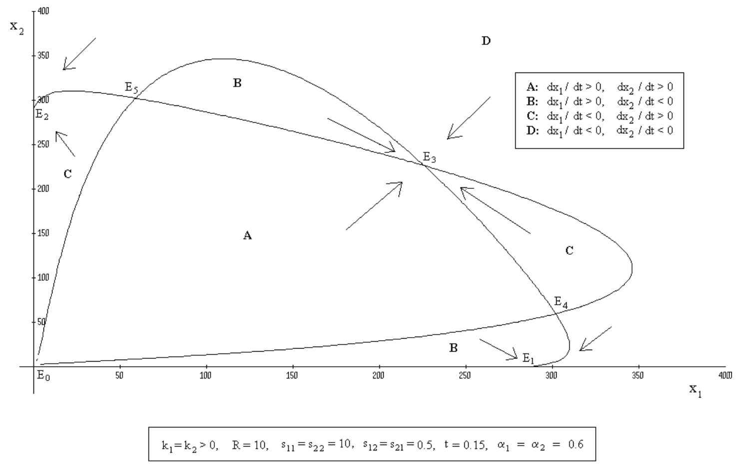
It is very important to note that the examination of the figures presented does not furnish an incontrovertible answer about the final output of a bipolar system with given initial conditions. We could in fact believe that if the initial values of x_1 and x_2 are in zone A and E_3 is stable, the system certainly will converge to E_3, but this is not always true, because much depends on the increasing speed of EPS *1* and *2*. Even if the k_i are equal, the growing speed is much influenced by the value of x_i. If the initial position of the system, for example, is near to the border between zone A and the part of zone B near to the x_1 axes (i.e. if x_1 is far greater than x_2), the increasing speed of EPS *2* will be far lower than that of EPS *1* (see in this regard the model 4.1.1), with the result that the system will be rapidly pushed to zone B which has E_4 as its vertex, where only x_1 will continue to grow, but only until the system enters zone D to converge on E_1. This situation is briefly shown already in Figure 4.2.2 (trajectory at the bottom of the panel). Figure 4.2.8 shows instead a numerical simulation of this situation, with an initial value of x_1 (*500*) far higher than the initial value of the x_2 (*100*). While the first grows rapidly, the latter show a very small initial increase, followed immediately by a fall (due to the passage of the system into zone B). Later, due to the collapse of EPS *2*, also the x_1 fall, pushing the system towards E_1.

Finally, Figure 4.2.9 shows a similar situation, with the same initial values. The only different parameter is k_2, which is much bigger than k_1 (*0.006* against *0.001*): the increase of EPS *2*, due to the big growth coefficient, is so high that the system is prevented from surpassing the line

$$0 = k_2 x_2 \left[\left(\sum_{j=1}^{2} \frac{s_{ij} x_j}{R_{ij} + x_j} \right) x_2^{\alpha_2} - \sum_{j=1}^{2} t_{ij} x_j \right]$$

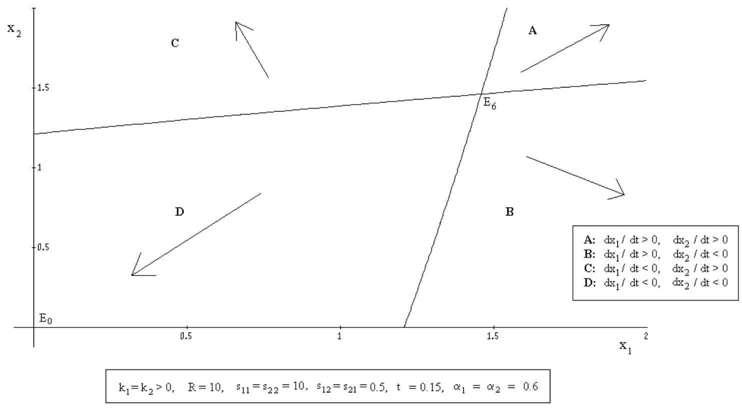
, going into the zone B and then converging on E_3.

Figure 4.2.1a



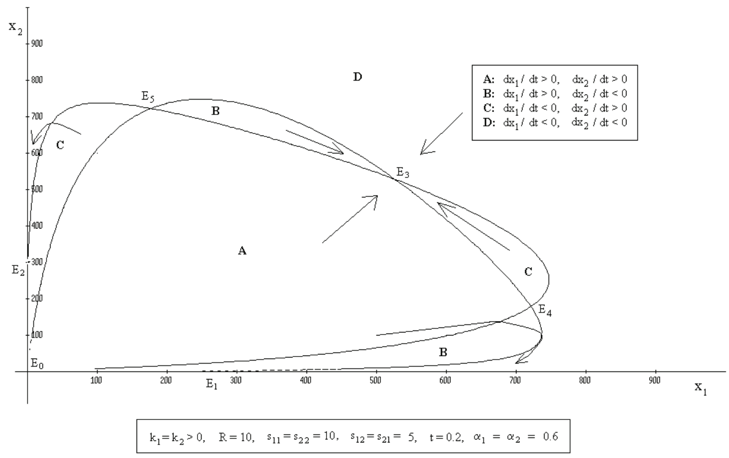
The diagram shows the behaviour of EPS *1* and *2* in dependence of the values of x_1 and x_2, given certain values of the parameters. The values of the coefficients s_{12} and s_{21}, which express the tendency to cooperate with the other EPS, are very low (*0.5*). In the equilibrium point E_3 the mass of the single EPS is smaller than the mass of the winning EPS in the equilibrium points E_1 and E_2, even if the whole mass $x_1 + x_2$ is greater in these points.

Figure 4.2.1b



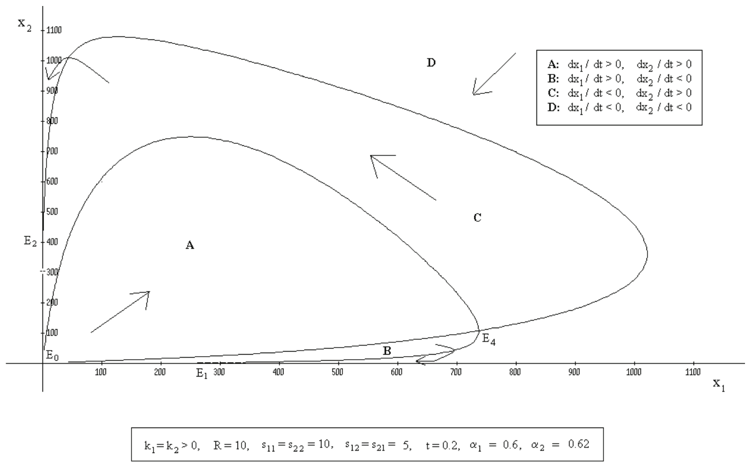
The diagram shows a detail of Figure 4.2.1a, showing that near the origin of axes there is an area **D** gravitating around the equilibrium point E_0 (extinction of both EPS).

Figure 4.2.2



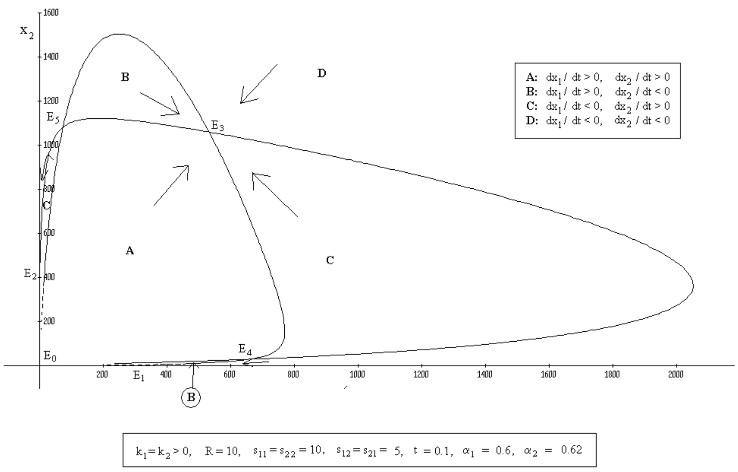
The graph shows a situation analogous to that presented in Figure 4.2.1a, except for the values of s_{12} e s_{21}, significantly higher (5 rather than 0.5). The equilibrium point E_3, in which both the EPS are vital, implies a mass of single EPS far bigger than in the equilibrium points E_1 and E_2. The coordinates of these equilibrium points are the same as the corresponding points in Figure 4.2.1a.

Figure 4.2.3



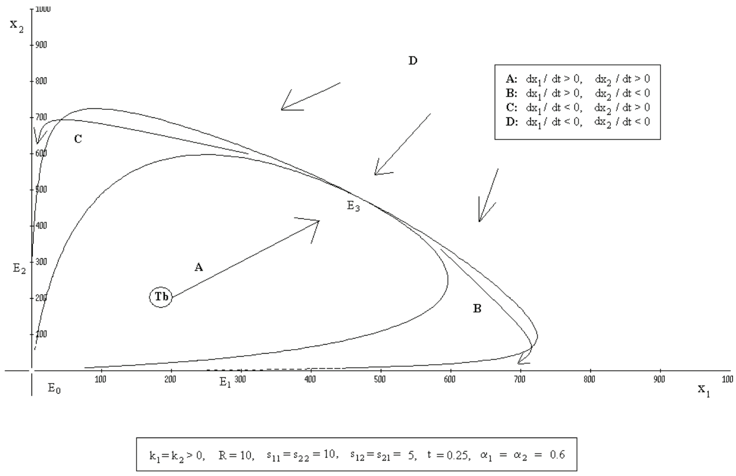
The graph shows that, by varying the value of α_2 a little (from *0.6* to *0.62*), due to an innovation, the equilibrium point E_3 disappears (because of the growth of area **C**).

Figure 4.2.4



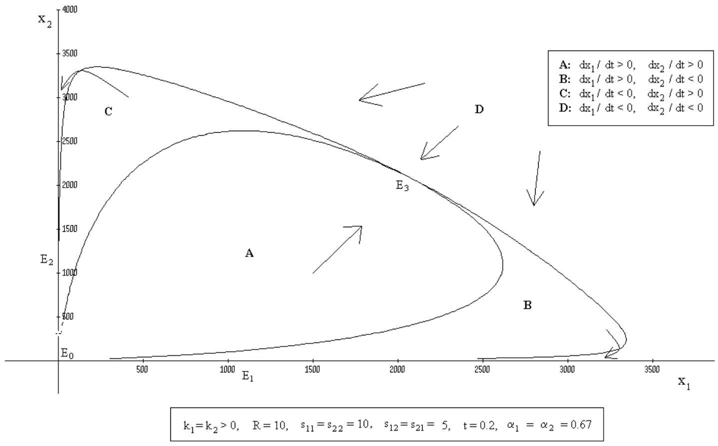
The graph shows a situation like that of Figure 4.2.3 (with $\alpha_2 > \alpha_1$), but with *t* much less (*0.1* instead of *0.2*). The equilibrium point E_3 is present here, and also the areas **B** and **C** next to the axes, leading to the extinction of one of the two organizations (equilibrium points E_1 and E_2), are very small.

Figure 4.2.5



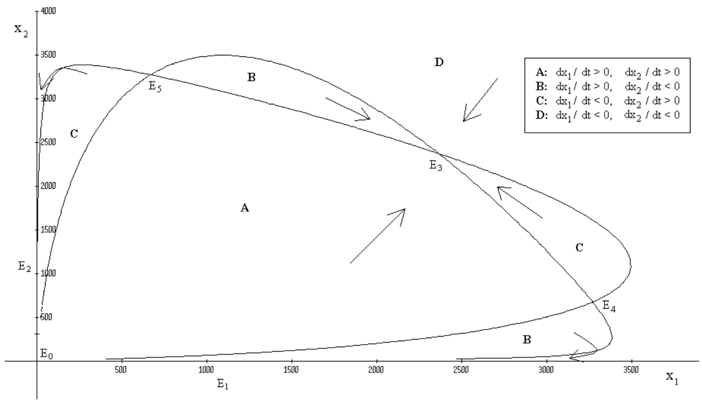
The values of the parameters, except the value of *t* which is considerably higher (*0.25*), are the same as Figure 4.2.2. The higher value of *t* causes the inversion of the position of the areas B and C near equilibrium point E_3, which therefore becomes instable. Only trajectory *Tb*, with identical values of x_i, can lead to E_3. Points E_4 and E_5 disappear.

Figure 4.2.6



The graph shows that with technological progress (values of α_i higher than those in Figure 4.2.2) equilibrium point E_3 becomes instable.

Figure 4.2.7

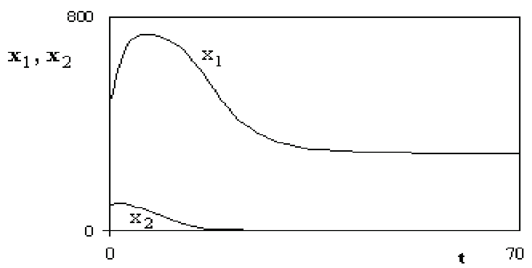


$k_1 = k_2 > 0$, $R = 10$, $s_{11} = s_{22} = 10$, $s_{12} = s_{21} = 5$, $t = 0.15$, $\alpha_1 = \alpha_2 = 0.67$

The values of the parameters are the same as Figure 4.2.6, changing only the value of t, which is lower. The graph shows that, increasing the values of α_i, it is necessary to reduce t to conserve the stability of equilibrium point E_3.

Figure 4.2.8

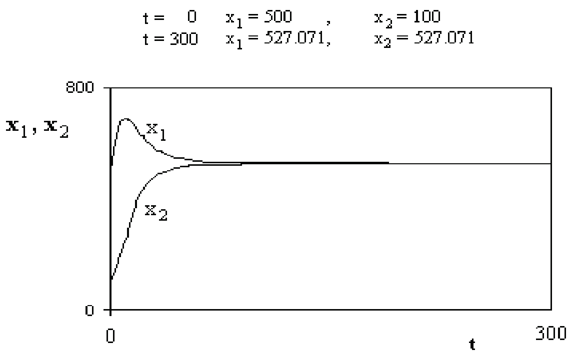
t = 0 x_1 = 500 , x_2 = 100
t = 70 x_1 = 290.618, x_2 = 0



$k_1 = k_2 = 0.003$, other parameters as in Figure 4.2.2

The numerical simulation presented in the diagram shows the evolution of two EPS starting from initial values placed in zone A (characterized by the growth of both the EPS). The initial value of x_2 is however quite close to the B-South zone (see Figure 4.2.2) and therefore its initial growth is much slower than that of x_1: the system moves into this zone and converges on the point E_1 (extinction of EPS 2).

Figure 4.2.9



$k_1 = 0.001$, $k_2 = 0.006$, other parameters as in Figure 4.2.2

The diagram shows the evolution of two EPS starting from the same initial values as Figure 4.2.8. The value of k_2 is however much higher than the value of k_1 (0.006 against 0.001). The system converges on the equilibrium point E_3.

4.3. A Model with Variable Technological Level

We have up to now assumed the technological level as a given. We have said, however, that the innovations can be divided into two categories, type A innovations, which are important and unpredictable changes, and type B innovations, which are predictable improvements in the productive organization, production techniques and products. While it is difficult to predict the former, it is instead possible to incorporate the latter into a deterministic model, like the one we have presented above (4.1.1). In it, then, the α_i can be assumed as variables, assigning them, in addition to an initial value, a potential value α_{iP}, justified by a type A innovation. The evolution from the initial value to the potential value, by means of a flux of type B innovations, can be assumed as deterministic. It is opportune to consider, moreover, that the applications of the innovations tend not to be confined to one EPS: consequently the α of an EPS can be influenced, if not directly by the type A innovations of an EPS j, at least by those of type B (for imitation) and therefore, if not by the potential value α_{jP}, at least by the effective value α_j. Building the general model which describes the evolution of the α_i, for the purpose of writing it in the most compact form, the potential value α_{iP} will be named α_j, with $j = i$. The model will then be the following:

for $\forall \alpha_j > \alpha_i$

$$\frac{d\alpha_i}{dt} = k_{\alpha_i} \alpha_i \sum_{j=1}^{n} \left[\frac{t_{ij} s_{ij} x_j}{R_{ij} + x_j} \left(\alpha_j - \alpha_i \right) \right] \quad (4.3.1)$$

where n indicates the number of EPS with $\alpha_j > \alpha_i$.

α_i therefore varies, according to a coefficient $K_{\alpha i}$, in dependence of its own value (as for all growing entities, the already reached mass favours its further variation, either positive or negative) and depending on the summation of the differences between the potential values, represented by those values of the α_j greater than α_i , and the effective value α_i. The fractional term

$$\frac{t_{ij} s_{ij} x_j}{R_{ij} + x_j}$$ measures, together with k_{α_i},

the speed of the flow of innovations or information able to increase α_i. It is reasonable in fact to assume that this speed is affected by the synergies, because they favour the circulation of ideas. The value of these synergies is multiplied for the concurrence coefficient t_{ij}[11], because even if concurrence tends to impede the flux of ideas from the innovators, it can favour it due to the incentive for the other operators to imitate the innovators.

It is evident that in the (borderline) case in which the relations are only of a synergic or only of a concurrent type, the model will not measure the flow of ideas. We can see, however, that EPS which have no synergy or concurrence relations with a given organization can influence it by means of intermediate EPS.

Examples are presented below in figures 4.3.1-4.3.3 of some numerical simulations showing the interaction between two EPS, with identical values of the coefficients of synergy and competition, in presence of type A innovations. In this case, too, the form coefficients and the competition coefficient will be identified only by *R* and *t*.

Figure 4.3.1 shows the evolution of the two EPS, from equal initial values and the same parameter values, except α_{iP} (*0.62* in EPS *1* and *0.6* in EPS *2*). We can see that EPS *2* collapses.

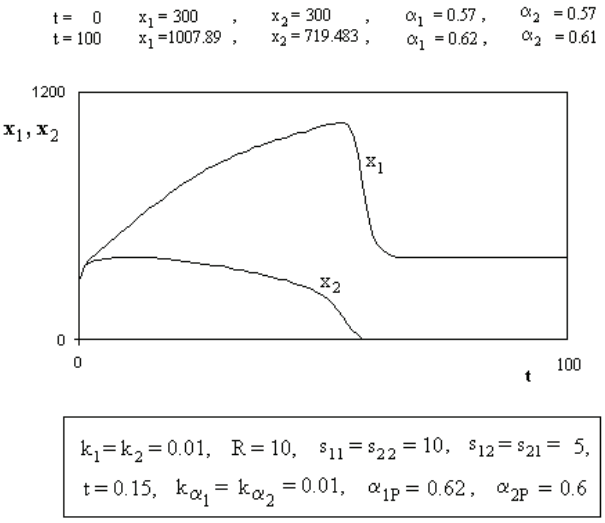
Figure 4.3.2, similar to what we saw earlier (Figure 4.2.4), shows that it is sufficient to reduce the competition coefficient to permit the survival of both the EPS.

Finally, Figure 4.3.3 shows how important the speed of adopting innovations is. The values of the parameters and the initial conditions are the same as Figure 4.3.1, except for the coefficient of adoption speed, much greater in EPS

[11] Remember that $t_{ii} = 1$, at least in the case of an internally homogeneous EPS.

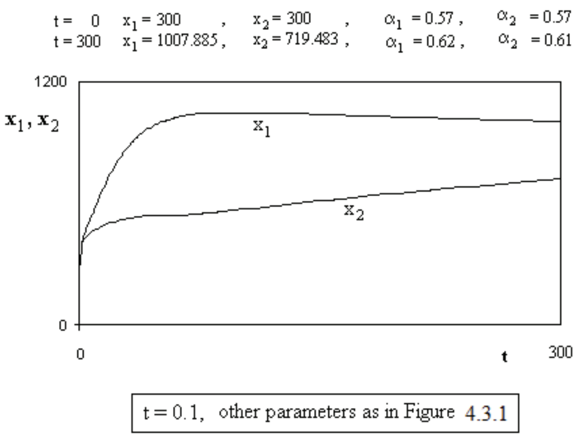
2 ($k_{\alpha 2}$ is *0.03*, while $k_{\alpha 1}$ is *0.01*). As a result, unlike what we have seen in Figure 4.3.1, EPS *2* does not collapse.

Figure 4.3.1



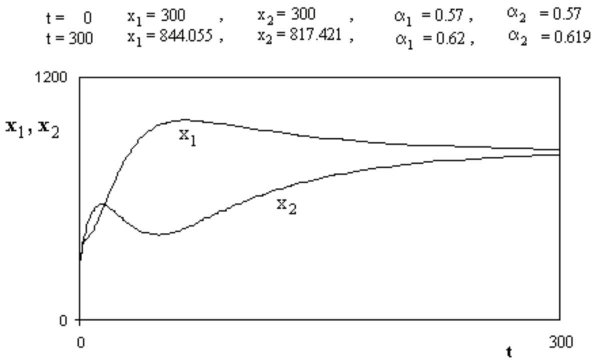
Organization 1 benefits from a more efficient innovation of type A: $\alpha_{1P} > \alpha_{2P}$. The EPS *2* collapses.

Figure 4.3.2



The initial conditions and the values of parameters are the same as Figure 4.3.1, except for the competition coefficient *t*, which is less: both EPS develop and coexist.

Figure 4.3.3



$k_{\alpha_1} = 0.001$, $k_{\alpha_2} = 0.003$, other parameters as in Figure 4.3.1

Compared with Figure 4.3.1, only the value of variation coefficient $K\alpha_2$ changes (it is significantly higher). Organization *2*, therefore, does not collapse.

5. Conclusions

One of the first conclusions that we reach by studying the model proposed in the previous section is that the process of economic interaction between EPS can lead to a reduction in the number of EPS and that the more intense the competition and the lower the propensity to cooperate and emulate, the greater this phenomenon is. At the same time the model also shows that the technological progress allows an EPS to increase its area of influence, reducing the economic and productive role of the EPS which can not readily adjust their technological level or do not implement strategies to diversify their production, specializing in the use of other resources.

In the light of these results and taking into account the considerations in paragraphs 2 and 3, the model appears to provide an explanation of the differences between the developmental trajectories followed by the various Eurasian civilizations. Naturally it is only a theoretical model which, beyond the simplifications mentioned above, takes into account only economic phenomena, therefore excluding political and military factors which may well be of fundamental importance in determining development processes on different geographical scales (causing, for example, the prevalence of one EPS over another, perhaps economically stronger one).

It should however be stressed that the aim of this contribution, beyond providing an interpretation of the divergence in the development trajectories of Eurasian civilizations, is also to show that among the factors determining this difference there is also a different configuration of the economic space.

Regarding the western part of Eurasia, as already mentioned, it is necessary to note that between Roman world and early medieval Europe there is a fundamental difference. The former truly rose, as a power, with the duel between Rome and Carthage, which lay the foundation for the establishment of an empire centred on the Mediterranean, in the double sense that this was its geographic centre – in which, furthermore, Rome had a central position – and the economic medium. Rome in fact would be fed with the wheat of Africa and its power, though already beginning to decline in the second half of the second century, would be destroyed only when the Vandals broke up this trade.

This is an essential feature which will no longer be reproduced in the course of subsequent history. In Antiquity the Roman state, after the defeat of Carthage, had almost no rivals, at least in the western Mediterranean, and so could easily extend its domain in every direction. In later times, instead, once the Italy-North Africa axis was broken up, there would not be a single power in the centre of the Mediterranean that could unify it. Due to the Roman colonization too, which created the conditions for the existence of complex societies in Western Europe, Europe was to be divided into states in substantial balance, the largest of which would be positioned, moreover, in unusual positions in relation to the Mediterranean basin.

The European world was born then as a set of territorial political entities, for which the sea was often a border, and even when it was a medium of trade it did not become the centre of the state, which maintained its core on the continent.

It is no coincidence that the maritime republics, whose territorial dimension was very small if compared with that of other kingdoms bordering the Mediterranean, operated successfully in trade because in the period of their ascent none of those kingdoms seemed to consider the sea anything more than a border and therefore wanted to extend their power over it. There would be an empire on the continent, but based on a very different production system from that of the Romans and also characterized by an extreme fragmentation of power.

Europe, essentially, would continue to be formed by a set of competing powers, but in constant communication with each other, by means of a common cultural language and a convergent worldview.

Due to the territoriality of their economies, these powers would remain essentially in equilibrium, also because of the morphology of this continent. In fact the competition would be insufficient to eliminate all players, and this would happen above all because, due to the reduced shipping capacities, the synergies within each EPS (s_{ii}), unlike what occurred in the ancient Roman world, which had at its geographic and economic centre the Mediterranean, would never be intense enough to increase the capacity growth of the single EPS until they could overwhelm the others.

The various powers, with the advance of technology, due to the relative wealth of the territory, would expand without exceeding the natural barriers posed between one region and another. Even once the dominion of the sea was regained, ideas would circulate and competition would often be only economic, or it would be directed to the nascent colonial empires. Basically the scenario in Europe, once divided from the rest of the Mediterranean region due to political and economic events and religious barriers, would evolve as a system represented by EPS with relatively low values of t_{ij} (con $j \neq i$) and relatively high values of s_{ij} (with $j \neq i$) and $K_{\alpha i}$.

The competition between the Chinese states during the period of fragmentation, instead, would be higher due to the scarce presence of geographical barriers and because the Chinese territory is more compact and characterized by numerous navigable rivers to which a network of interconnected canals would be added. The presence of large rivers, moreover, will favour a political centralization which would not be aimed exclusively at predatory exploitation, as more likely occurs when the communication route was represented by sea, but also to the necessary coordination (represented by a relatively high value of internal synergies s_{ii} of the sole surviving EPS, synergies which would still permit a great production and, consequently, a large population).

As regards India, we can distinguish in it at least two great areas: the plains of the Indus and the Ganges in the north and Deccan in the south. This second area, in particular, extends primarily from north to south and has coastal mountain chains and other geographic barriers; it was rarely combined in a single political entity, and when that occurred, such entities generally originated in the Indus-Ganges region, more homogeneous and more easily viable. The Indus-Ganges plain, furthermore, is bordered to the north-west with steppe areas which exposed it to easy invasions by warriors accustomed to the use of horse, little used in the Indian region, unsuited to its breeding (see Keay, 2001 [2000]). India, like Western Europe and China, offered many resources for maintaining populous states. However, its heterogeneity and its geographical and climatic barriers, unlike China, hampered not only its unification, but also competition and, therefore, emulation (value of the $K_{\alpha i}$), at least in comparison with Europe.

Finally, as regards the large area of steppe and grasslands, we see in them the frequent formation of large state entities, though often not lasting and based on tribal foundations. These territories are not able to support large populations, but they can be easily crossed using horses, camels or dromedaries.

Scarce resources, inconsistent geographic and climatic barriers and the presence of fast means of locomotion suggest predatory economies, characterized by very high values of t_{ij} (with $j \neq i$).

Returning to Europe, we can note that it, once separated from the other territories around the Mediterranean, beyond presenting the characteristics mentioned (summarized by high values of $K_{\alpha i}$ and s_{ij}, and low values of t_{ij}) also showed two fundamental features: one, more deterministic, of a geographic kind, the other of a human type and, therefore, generating less predictable effects. The first was its not unbridgeable distance from America, a sparsely populated and still not technologically advanced continent, the second was an economy that gave everyone, if not wealth, then the opportunity to choose (at least from the time of the Crusades) the direction of his life. This possibility of choice, combined with a collective context permeated by a desire to recover an imperial greatness seen as the culmination of a destiny of evangelization of Europe, in a historical vision that was not cyclical as in the Ancient world, but linear, probably underlies not only Europe's capacity to resist invasions and even to start expanding again, but also its progress towards Modernity.

References

Baschet, J. 2005. *La civiltà feudale. Sei secoli di storia, dall'anno Mille alla colonizzazione dell'America*, Roma: Newton Compton. Italian edition of *La civilisation féodale* (2004), Paris: Éditions Flammarion.

Buchanan, M. 2008. *L'atomo sociale. Il comportamento umano e le leggi della fisica*, Milano: Mondadori, Italian edition of *The Social Atom* (2008).

Cameron, R. 2005. *Storia economica del mondo*, Vol. 1 (*Dalla preistoria al XVII secolo*). Bologna: Il Mulino. Italian translation of *A Concise Economic History of the World* (2003). fourth edition. Oxford: Oxford University Press.

Cipolla, C. M. 1985. *Storia economica dell'Europa preindustriale*. Bologna: Il Mulino.

Cosandey, D. 1997. *Le secret de l'Occident*. Paris: Arléa.

Diamond, J. 2006. *Armi, acciaio e malattie. Breve storia del mondo negli ultimi tredicimila anni*. Torino: Einaudi. Italian edition of *Guns, Germs, and Steel. The Fates of Human Societies* (first edition 1997). New York: W. W. Norton & Company.

Diamond, J. 2005 and 2007. *Collasso. Come le società scelgono di morire o vivere*. Torino: Einaudi. Italian edition of *Collapse. How Societies Choose to Fail or Succeed* (2005). New York: Wiking Books.

Diaz-Alejandro, C. 1985. "Good-Bye Financial Repression, Hello Financial Crash." *Journal of Development Economics* 19 (1/2): 1-24.

Duby, G. 1992. *Le origini dell'economia europea, Guerrieri e contadini nel medioevo*. Roma-Bari: A. Mondatori (1992). Laterza (1975). Italian translation of *Guerriers et paysans. VII-XIIe siècle. Premier essor de l'économie européenne* (1973). Paris: Éditions Gallimard.

Duncan-Jones, R. P. 1994. *Money and Government in the Roman Empire.* Cambridge: Cambridge University Press.

Gibbon, E. 1776. *The history and the Decline and Fall of the Roman Empire*.

Heather, P. 2007. *The Fall of the Roman Empire: A New History of Rome and the Barbarians*. Oxford: University Press.

Homer-Dixon, T. 2006. *The Upside of Down: Catastrophe, Creativity, and the Renewal of Civilization*. Alfred A. Knopf Canada / Random House of Canada Limited.

Hong, S., J. P. Candelone, C. C. Patterson, and C. F. Boutron. 1994. "Greenland Ice Evidence of Hemispheric Lead Pollution Two Millennia Ago by Greek and Roman Civilizations." *Science* (265): 1841-1843.

Hong, S., J. P. Candelone, C. C. Patterson, and C. F. Boutron. 1996. "History of Ancient Copper Smelting Pollution During Roman and Medieval Times Recorded in Greenland Ice." *Science* (272): 246-249.

Hong, S., J. P. Candelone, M. Soutif, and C. F. Boutron. 1996. "A Reconstruction of Changes in Copper Production and Copper Emissions to the Atmosphere during the Past 7000 Years." *The Science of Total Environment* (188): 183-193.

Hopkins, K. 1981. "Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400)." *The Journal of Roman Studies*: 101-125.

Keay, J. 2001. *Storia dell'India*. Roma: Newton & Compton Editori. Italian translation of *India. A History* (2000). New York: Harper Collins Publishers.

Lang, G. 1997. "State systems and the origin of modern science: a comparison of Europe and China." *East-West Dialog* (II): 16-30.

Lo Cascio, E. 2003. Il denarius e gli scambi intermediterranei. In *Moneta Mercanti Banchieri. I precedenti greci e romani dell'Euro. Atti del convegno internazionale, Cividale del Friuli, 26-28 settembre 2002*, 147-165. Pisa: Fondazione Niccolò Canussio.

Marshall, A. 1919. *Industry and Trade*. London: Macmillan and Co.

Olsson, O., D. A. Hibbs. 2005. "Biogeography and long-run economic development." *European Economic Review* (49): 909-938.

Paolilli, A. L. 2005a. "Commercio marittimo e sviluppo nel tardo Medioevo." *Nuova rivista storica*. Milano: Società Dante Alighieri, Anno 89, n. 3: 585-602.

Paolilli, A. L. 2005b. "Development and Crisis in the Late Middle Ages: the Role of Trade." *The Journal of European Economic History*. Roma: Capitalia, vol. 34, n. 3: 687-717.

Paolilli, A. L. 2008. "Development and crisis in ancient Rome: the role of Mediterranean trade." *Historical Social Research* 33 (4): 274-289.

Paolilli, A. L. 2009. "About the 'Economic' Origin of Altruism." *The Journal of Socioeconomics* 38 (1): 60-71.

Parker, A. J. 1992. *Ancient Shipwrecks of the Mediterranean & the Roman Provinces*. Oxford: British Archaeological Reports. Rostovcev, M. I. (1926). *The Social and Economic History of the Roman Empire*.

Pirenne, H. 2000. *Maometto e Carlomagno*. Bari: Laterza. Italian translation of *Mahomet et Charlemagne* (1937). Bruxelles: Nouvelle Société d'Èditions.

Pomeranz, K. 2000. *The Great Divergence: China, Europe, and the Making of the Modern World Economy.* Princeton: Princeton University Press.

Prigogine, I. 1979. *La nuova alleanza, uomo e natura in una scienza unificata.* Milano: Longanesi.

Scheidel, W. 2007. *The 'First Great Divergence': Trajectories of post-ancient state formation in eastern and western Eurasia.* Princeton / Stanford Working Papers in Classics.

Schiavone, A. (2002 [1996]). *La storia spezzata, Roma antica e Occidente moderno*. Roma-Bari: Editori Laterza.

Schumpeter, J. (1911). *Theorie der wirtschaftlichen Entwicklung.* München – Leipzig, Duncker & Humblot; II ed. 1926, III ed. 1931, IV ed. 1935, English edition: *The theory of economic development* (1934), Cambridge (Mass.): Harvard University Press.

Walbank, F. W. 1946. *The Decline of the Roman Empire in the West*. London: Cobbett Press.

Wickham, C. 2005. *Framing the early Middle Ages: Europe and the Mediterranean, 400-800*. New York: Oxford University Press.

Ward-Perkins, J. B. 2005. *The Fall of Rome: And the End of Civilization*. Oxford: Oxford University Press.